



# Cellular Neural Networks with Switching Two Templates for Edge Detection

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## 1 Introduction

In the image processing of the Cellular Neural Networks (CNN), it is difficult to process complex parts of the input image; edge, background, etc. Some researches are reported that it is possible to process complex parts by switching two templates which have the different feature. Therefore, we propose a new CNN method of switching two templates;  $3 \times 3$  and  $5 \times 5$  templates by using the maximum and the minimum output values surrounding the center cell. We apply the proposed method to edge detection and investigate its performance.

## 2 Proposed Method

The feature of the proposed method is switching two templates by using the maximum and the minimum output values ( $v_{ymax}$ : cell's maximum output value,  $v_{ymin}$ : cell's minimum output value) surrounding the center cell. The concept of this proposed method is shown in Fig. 1.

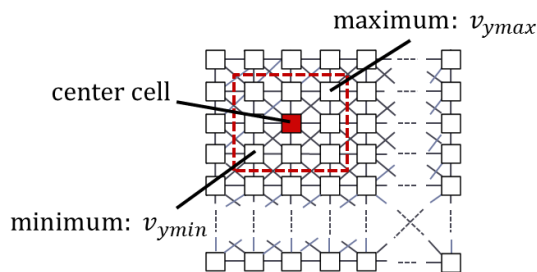


図 1 Proposed CNN

The processing steps of the proposed method are described as follows :

**Step 1:** First, decide the center cell. Then, find the  $v_{ymax}$ , and  $v_{ymin}$  from the  $3 \times 3$  neighborhood.

**Step 2:** Secondly, calculate the difference value between  $v_{ymax}$  and  $v_{ymin}$ ;  $|v_{ymax} - v_{ymin}|$ .

**Step 3:** Thirdly, determine the template by the threshold value  $a$  according to the following equations.

$$\begin{aligned} 3 \times 3 \text{ template: } & |v_{ymax} - v_{ymin}| \leq a \\ 5 \times 5 \text{ template: } & |v_{ymax} - v_{ymin}| > a. \end{aligned} \quad (1)$$

**Step 4:** Finally, Step 1 to step 3 are applied to all cells and repeated every  $0.15 [\tau]$ .

## 3 Simulation Results

We apply the proposed method to edge detection. We use the edge detection template [1]. Figure 2 shows the input image and simulation results by using only  $3 \times 3$  template, only  $5 \times 5$  template, and the proposed method. The defocused parts of the input image are the left-side pillar and the woman's silhouette. In Fig. 2(b), the defocused parts are not detected by using  $3 \times 3$  template. On the other hand, in Fig. 2(c), the defocused parts are detected by using  $5 \times 5$  template. However, some noise remains at woman's hat and silhouette. In Fig. 2(d), the defocused parts can be detected clearly. In addition, noise is removed especially woman's hat and silhouette.



図 2 Simulation results. (a) Input image. (b) Simulation result using the  $3 \times 3$  template. (c) Simulation result using the  $5 \times 5$  template. (d) Simulation result of the proposed method ( $a = 0.7$ ).

## 4 Conclusions

In this study, we have proposed a new CNN method of switching two templates. The simulation results show that the proposed method is effective to detect edge lines of the defocused parts and to remove some noise. Therefore, the proposed method is more effective than the conventional CNN in edge detection.

## REFERENCES

- [1] Y. Kato, Y Ueda, Y Uwate and Y Nishio, "Cellular Neural Networks with Switching Two Types of Templates," Proc. of IJCN' 11, pp. 1423-1428, Jun. 2011.